Spinal Cord (2021) 59:429–440
https://doi.org/10.1038/s41393-020-00598-x

ISCoS The International Spinal Cord Society

ARTICLE

SwiSCI 360° Perspective—Results from the Swiss SCI Survey 2017

Labor market participation of individuals with spinal cord injury living in Switzerland: determinants of between-person differences and counterfactual evaluation of their instrumental value for policy

Urban Schwegler[1,2] · Christine Fekete[1,2] · Monika Finger[1,2] · Katarzyna Karcz[1,2] · Stefan Staubli[3] · Martin W. G. Brinkhof[1,2]

Received: 28 February 2020 / Revised: 20 November 2020 / Accepted: 20 November 2020 / Published online: 14 January 2021

Abstract

Study design Longitudinal, population-based survey.

Objective To examine determinants of between-person differences in labor market participation of individuals with spinal cord injury (SCI) living in Switzerland and their potential importance for policy.

Setting Community.

Methods Longitudinal information on labor market participation (i.e., paid work or not) was obtained from 1198 and 1035 individuals of working-age participating in the 2012 and 2017 SwiSCI community survey, respectively. Determinants of between-person variation in labor market participation were examined using mixed effects logistic regression, controlling for within-person variation. Employment rates were predicted using counterfactual data for modifiable determinants.

Results The employment rate was 56% for the 2012 and 61% for the 2017 survey. Labor market participation was affected mostly by static (sex, nationality, SCI severity), temporal (age), dynamic (education level, functional independence, chronic pain), and policy-related (general pension, disability pension level) determinants. Counterfactual (what-if) predictions indicated the highest improvement of employment rates for strategies that increase functional independence (up to 6% increase), foster education (5%), reduce chronic pain (2%), or promote a shift to partial disability pensions (15%).

Conclusions Between-person variation in labor market participation of persons with SCI is influenced by various temporal, static, dynamic, and policy-related determinants. Our results suggest that policy strategies aimed at enhancing the employment rate of the Swiss SCI population may particularly invest in programs promoting functional independence, education, and partial pension levels that are more adequate for ensuring sustainable employment.

Introduction

Persons of working age who are living with a spinal cord injury (SCI) may experience fundamental restrictions in labor market participation (LMP) that can affect their income, self-esteem, social integration, and quality of life [1, 2] but also cause high economic burden for society in terms of indirect social costs [3]. Employment may facilitate social interactions and help people with SCI to develop a personal identity [4]. Therefore, a key goal of SCI rehabilitation and integration concerns opportunities to return to and maintain paid work [5]. LMP of persons with SCI varies widely across countries, with employment rates between 11.5 and 74% [2], depending, among others, on country-specific social policy regulations, labor market dynamics and structures, and return-to-work incentives. In Switzerland, in 2012 the employment rate of people with SCI was 53%, around 30% points lower than in the general population [6].

Cross-sectional research suggests that the LMP of persons with SCI is determined by a variety of non-modifiable and modifiable factors. A wealth of research has revealed an

Supplementary information The online version of this article (https://doi.org/10.1038/s41393-020-00598-x) contains supplementary material, which is available to authorized users.

✉ Urban Schwegler
urban.schwegler@paraplegie.ch

[1] Swiss Paraplegic Research, Nottwil, Switzerland

[2] Department of Health Sciences and Medicine, University of Lucerne, Nottwil, Switzerland

[3] Swiss Paraplegic Center, Nottwil, Switzerland

impact of *static determinants* such as sex, ethnicity, or SCI severity as well as pre-injury education, employment, and job type [7–9] that are typically not modifiable targets for interventions. The same holds true for *temporal determinants* such as age and time since SCI [1]. In terms of *dynamic determinants* that are potential targets for medical or vocational interventions, there is evidence for the impact of secondary health conditions [10], psychiatric comorbidities [11], functional independence [12], workplace accessibility [8], and psychological personal factors [13]. In addition, *policy-related determinants* that are usually only amenable by broader policy strategies, such as poor transportation services or financial disincentives by insurance companies, may impede LMP [8]. Overall, modifiable factors that are most consistently associated with LMP per the literature are education, vocational rehabilitation, functional independence, social support, and financial disincentives [7]. For Switzerland, there is evidence for the association of paid work with static (male gender, Swiss nationality, lower SCI severity, traumatic etiology), temporal (age), and dynamic (education, functional independence, chronic pain, urinary tract infection, pressure ulcer, depression) determinants [6, 10, 14]. Qualitative findings indicate an impact of financial disincentives resulting from disability pension levels [15].

Due to its cross-sectional nature, the existing evidence is of limited value in specifying factors that determine LMP of persons with SCI over time. Moreover, the scant evidence from longitudinal research [13, 16] is generally also inconclusive, because analytical methods employed failed to discriminate between-person variation from within-person variation in LMP. It thus did not account for latent (unmeasured) individual determinants of variation in LMP. To optimally inform policy strategies to enhance employment rates at the population level *as well as* vocational rehabilitation interventions to promote LMP at the individual level, it is crucial to evaluate determinants of between-person variation in LMP that are corrected for within-person sources of variation. This is particularly important for a condition like SCI where LMP is dynamically determined by a variety of factors. Counterfactual prediction models that forecast LMP in response to conceivable changes in modifiable determinants can shed light on the promise of policy strategies to enhance employment rates. With the completion of the second community survey of the Swiss Spinal Cord Injury Cohort Study (SwiSCI) [17] in 2017, the critical longitudinal information for such analyses has become available.

The present study aimed to examine between-person differences in LMP of community-dwelling individuals with SCI living in Switzerland. Specifically, we aimed to (1) describe the LMP in 2012 and 2017, by selected static, temporal, dynamic and policy-related characteristics; (2) evaluate static, temporal, dynamic, and policy-related determinants of between-person differences in LMP, controlling for within-person variation; and (3) derive counterfactual predictions for the employment rate using alternative population distributions of modifiable dynamic and policy-related determinants.

Methods

Design

We conducted a longitudinal, population-based study using data of community-dwelling individuals with SCI who participated in the 2012 and 2017 SwiSCI community survey [17–19]. Multilevel mixed effects logistic regression was used to evaluate determinants of between-person variation in LMP. For modifiable determinants, reflecting potential targets for policy interventions, counterfactual predictions were derived for different scenarios that may improve the employment rate.

Participants

The SwiSCI survey aimed to study all Swiss residents aged over 16 years with a traumatic or nontraumatic SCI and was (so far) conducted in 2012 and 2017. Individuals with congenital conditions leading to SCI, neurodegenerative disorders, and Guillain–Barré syndrome were excluded. Due to the lack of a central register of persons with SCI living in Switzerland, the SwiSCI study sample was established based on registries maintained by specialized SCI rehabilitation centers, the Swiss Paraplegic Association, and ParaHelp (the specialized home care institution for individuals with SCI in Switzerland). Details on the SwiSCI study design and recruitment strategy are provided elsewhere [17–19]. The present study used data of working-age participants (the statutory working age in Switzerland is 16–63 years for females and 16–64 years for males) who completed the first two out of three questionnaire modules in 2012 and the first of two modules in 2017.

Measures

The SwiSCI questionnaire modules are available online [20]. Information on the study's outcome variable, *LMP at time of the survey*, was collected with a multiple-choice question ("What is your current working situation?") offering the following response categories: (1) working for wages with an employer, including paid vocational training, (2) self-employed, (3) unpaid work in family business, (4) working in a sheltered workshop, (5) vocational training or retraining, unpaid, (6) student, (7) housewife, househusband, (8) unemployed, (9) receiving a disability or another pension, (10) retired due to health condition, (11)

retired due to age, (12) other. The outcome variable was coded dichotomously (categories (3) to (12) were recoded to 0 = no paid work, categories (1) and (2) to 1 = paid work).

Predictor variables were selected from the available evidence on determinants of LMP of persons with SCI living in Switzerland that is mainly based on cross-sectional analyses of SwiSCI 2012 survey data [6, 10, 14, 15]. *Temporal determinants* included *age at time of the survey*, *time since injury* (both in years) and *survey year* (0 = participation 2012, 1 = participation 2017). *Static determinants* involved *sex* (male, female), *nationality* (Swiss, non-Swiss), *SCI etiology* (traumatic, non traumatic), and *SCI severity*, based on a combination of level (paraplegia, tetraplegia) and completeness (complete, incomplete). *Dynamic determinants* comprised *education* (in years of pre- and post-injury education combined and categorized into compulsory (≤9 years), vocational (10–12 years), secondary (13–16 years), and university level (≥17 years)) [21]. We also included *functional independence*, using the 0–100 Rasch-based total score of the *Spinal Cord Independence Measure-Self Report* (SCIM-SR) [22, 23]. Information on selected secondary health conditions (*chronic pain*, *urinary tract infection*, *pressure ulcer*) was collected using the *Spinal Cord Injury Secondary Conditions Scale* [24], on which respondents report a condition's frequency and severity during the past 3 months on a 4-point Likert scale (no, mild, moderate, major problem). The presence of *depression* was measured with a "yes"/"no" question ("Please indicate whether or not you suffer from the particular disease") based on the *Self-Administered Comorbidity Questionnaire* [25]. Finally, information on *policy-related determinants* was collected with a multiple-choice question on financial compensation provided by the state or by private insurances. We distinguished compensation in terms of *general pension* (occupational pension, social benefits, unemployment pension, life insurance pension, family allowance, other benefits) and disability pension. Disability pension was further differentiated into *general disability pension* (helplessness allowance, accident injury pension, caregiver compensation) and work disability pension by the *Swiss Disability Insurance* ("Schweizerische Invalidenversicherung", IV), henceforth *IV pension*. General pension and general disability pension were coded binary, reflecting the number of pensions received (0 = no pension, 1 = one or more pensions). IV pension was reported with different levels (no, ¼, ½, ¾, full pension) and coded accordingly.

Data analysis

All analyses are based on self-report data and were conducted using Stata version 14.2 (College Station, TX, USA). First, we calculated descriptive statistics of static, temporal, dynamic, and policy-related participant characteristics for the SwiSCI 2012 and 2017 survey, by employment status. For the group of individuals participating in both surveys, we described their employment rate as well as their dynamic and policy-related characteristics in 2012 and 2017.

Second, we conducted multilevel mixed effects logistic regression to evaluate population-average estimates of determinants of LMP, controlling for survey year and for within-person variation in individuals who participated in both surveys, by declaring participant ID as a random effect parameter. This parameter accounts for person-specific effects that are unmeasured (latent), using repeated assessments of LMP in individuals who participated in both surveys. We used all data across both surveys, which implies an unbalanced data set with a different number of observations for participants contributing data to either one survey or both. Variation in LMP was analyzed using univariable and multivariable models. The multivariable models included three distinct sets of static, temporal, dynamic and policy-related determinants (see Fig. 1): (1) static and temporal determinants, (2) static, temporal and dynamic determinants, (3) static, temporal, dynamic, and policy-related determinants. P-values for determinants of between-person variation in LMP were derived using global likelihood ratio tests. Intra-class correlation coefficients (ICCs) between within-person variation and between-person variation were calculated for the null model, including ID but none of the selected determinants, and for the three multivariable models. Comparing the ICCs across the regression models, which successively add static, temporal, dynamic, and policy-related determinants, provides an estimate of the degree at which these factors explain the within-person correlation of LMP that is due to latent subject-specific differences.

Finally, we conducted a what-if analysis using counterfactual data for modifiable dynamic or policy-related determinants that were strongly related to between-person variation in LMP in the multivariable regressions. This simulation analysis used parameter estimates from the models 2 and 3 to derive counterfactual predictions of the employment rate based on alternative data for the study sample. These data were derived using a randomly selected group of participants who were exposed to alternative distributions regarding relevant dynamic or policy-related determinants and under a range of scenarios. For ordinal variables (e.g., pain), we used simulated scenarios of proportional change between 0 and 1 with steps of 0.2 for the proportion of participants changing to the adjacent and advantageous (with respect to LMP) level of the variable. For example, in the pain 0.4 scenario, pain severity level was changed in each simulation run for a random 40% of cases per level from level *major* to *moderate*, *moderate* to

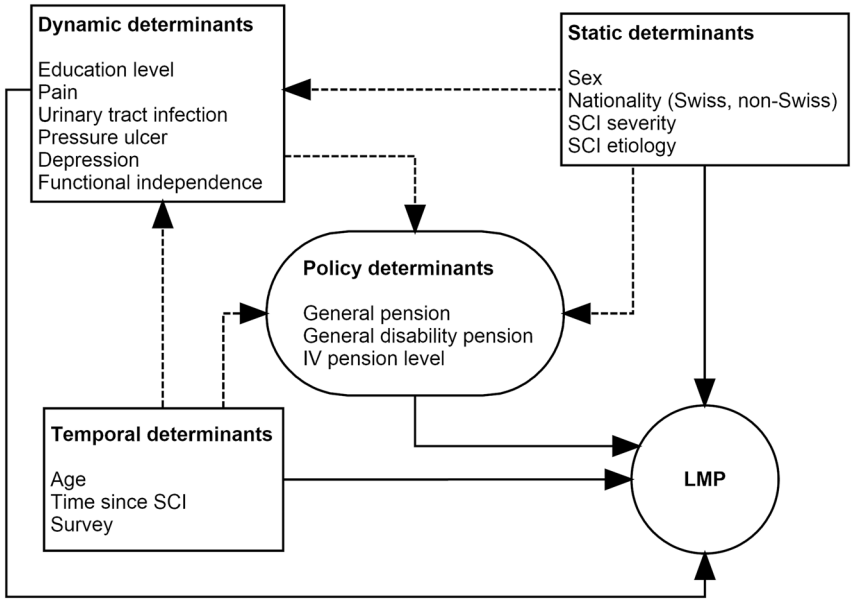

Fig. 1 Data analysis plan for the mixed effects logistic regression to evaluate between-person variation in LMP. *LMP* labor market participation, *SCI* spinal cord injury, *IV* Swiss Disability Insurance. Non-dashed lines represent associations of interest in the multivariable regression analysis, dashed lines reflect interrelationships that were not analyzed in the present study. Multivariable model 1 includes the temporal and static determinants, multivariable model 2 the static, temporal and dynamic determinants, and multivariable model 3 the static, temporal, dynamic, and policy-related determinants.

mild, and *mild* to *none*, respectively. As the counterfactual predictions of the overall employment rate for a given scenario and determinant showed minimal variation across simulation runs, pooled estimates over 5 runs are presented in the results.

Missing data

With the exception of the descriptive statistics, all analyses were performed using complete case data. This is in line with Twisk who showed that multilevel analysis (with full information maximum likelihood estimation) is rather robust to the issue of missing data [26].

Results

Sample characteristics and employment rates

Table 1 presents basic characteristics of the 1198 working-age participants of the SwiSCI 2012 and the 1035 of the SwiSCI 2017 survey, overall and separately for employed individuals. In both surveys, the majority of participants were male, between 40 and 54 years of age, had an incomplete paraplegia and a secondary education. The overall employment rate was 56% in 2012 and 61% in 2017.

A total of 523 individuals participated in both surveys. Their employment rates and dynamic and policy-related characteristics in 2012 and 2017 are presented in the *Supplementary Information*, indicating only small changes between the two survey years. While in 2012, 65.8% of the participants were engaged in paid work, 65.3% were so in 2017.

Determinants of between-person variation in LMP

Table 2 provides the determinants of between-person variation in LMP resulting from the univariable analysis and the three multivariable regression models. As indicated by the ICC of the null model, 80% of the longitudinal variation in LMP was explained by differences between persons and much less by within-person changes in the employment status over time. The multivariable models managed to explain around 2% (model 1), 12% (model 2), and 18% (model 3) of the between-person variation in LMP, while 62% (in model 3), 68% (in model 2), and 78% (in model 1) remained unexplained.

Static and temporal determinants

In the univariable analysis, age, sex, nationality, and SCI severity were strongly related to between-person variation in LMP. In the multivariable models 2 and 3, *nationality* represented an important determinant, with Swiss citizens being three to four times more likely to be involved in paid work. The same was true for *sex*, with males showing a more than twice higher LMP likelihood than females. *SCI severity* was a strong determinant only in model 2 with a 70% decreased LMP probability for persons with incomplete tetraplegia compared to those with incomplete paraplegia. Finally, *age* strongly determined LMP in both models, with 25–39 and 40–54-year-old persons being 9 to 19 times more likely to have paid work than the youngest age group.

Table 1 Participant characteristics of the SwiSCI 2012 and 2017 survey, overall and for employed individuals.

Parameter	2012		2017	
	Total	Employed [12[a]]	Total	Employed [13[a]]
Indicator variable [missing[a]]	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Total	1198 (100)	664 (56.0)	1035 (100)	623 (61.0)
Static and temporal characteristics				
Sex [0; 0]				
Female	327 (27.3)	151 (46.3)	285 (27.5)	151 (53.2)
Male	871 (72.7)	513 (59.7)	750 (72.5)	472 (64.0)
Age [0; 0]				
16–24 years	47 (3.9)	19 (40.4)	19 (1.8)	7 (36.8)
25–39 years	267 (22.3)	170 (64.4)	205 (19.8)	146 (72.6)
40–54 years	529 (44.2)	319 (60.7)	451 (43.6)	283 (63.6)
55–63/64 years	355 (29.6)	156 (44.7)	715 (32.0)	187 (52.4)
Nationality [38; 15]				
Non-Swiss	176 (15.2)	75 (43.6)	183 (17.9)	77 (43.8)
Swiss	984 (84.8)	570 (58.4)	837 (82.1)	536 (64.5)
SCI severity [10; 129]				
Paraplegia, incomplete	417 (35.1)	243 (58.6)	338 (37.3)	231 (69.0)
Paraplegia, complete	405 (34.1)	244 (60.4)	282 (31.1)	186 (66.4)
Tetraplegia, incomplete	228 (19.2)	111 (49.3)	187 (20.6)	96 (52.2)
Tetraplegia, complete	138 (11.6)	65 (47.1)	99 (10.9)	49 (49.5)
SCI etiology [14; 11]				
Non traumatic	142 (12.0)	61 (43.0)	157 (15.3)	86 (55.1)
Traumatic	1042 (88.0)	598 (57.7)	867 (84.7)	532 (62.1)
Time since injury [20; 76]				
<1 years	18 (1.5)	7 (38.9)	1 (0.1)	0 (0.0)
1–5 years	201 (17.1)	99 (50.3)	120 (12.5)	67 (57.3)
6–10 years	205 (17.4)	124 (61.1)	168 (17.5)	98 (58.7)
11–15 years	179 (15.2)	93 (52.0)	143 (14.9)	92 (64.3)
16–20 years	138 (11.7)	88 (63.8)	138 (14.4)	89 (65.0)
21–25 years	140 (11.9)	78 (55.7)	98 (10.2)	60 (62.5)
26–30 years	118 (10.0)	68 (57.6)	110 (11.5)	72 (65.5)
31–35 years	74 (6.3)	41 (55.4)	84 (8.8)	55 (67.1)
36+ years	105 (8.9)	60 (57.1)	97 (10.1)	49 (51.6)
Dynamic characteristics				
Education level [21; 41]				
Compulsory (≤9 years)	85 (7.2)	27 (42.5)	58 (5.8)	20 (35.1)
Vocational (10–12 years)	280 (23.8)	115 (41.5)	192 (19.3)	90 (47.4)
Secondary (13–16 years)	572 (48.6)	345 (60.3)	475 (47.8)	291 (61.8)
University (≥17 years)	240 (20.4)	172 (71.7)	269 (27.1)	211 (78.7)
Pain [52; 39]				
No problem	314 (27.4)	202 (64.3)	173 (17.4)	119 (68.8)
Mild problem	193 (16.8)	134 (69.8)	211 (21.2)	151 (72.6)
Moderate problem	238 (20.8)	137 (58.3)	278 (27.9)	171 (61.7)
Major problem	401 (35.0)	168 (42.6)	334 (33.5)	164 (49.9)
Urinary tract infection [63; 79]				
No problem	462 (40.7)	289 (62.8)	368 (38.5)	253 (69.1)
Mild problem	213 (18.8)	126 (60.0)	218 (22.8)	129 (60.3)

Table 1 (continued)

Parameter	2012		2017	
	Total	Employed [12[a]]	Total	Employed [13[a]]
Moderate problem	265 (23.4)	138 (52.7)	217 (22.7)	125 (57.9)
Major problem	195 (17.2)	82 (42.5)	153 (16.0)	83 (55.3)
Pressure ulcer [89; 98]				
No problem	729 (65.7)	426 (58.8)	584 (62.3)	395 (68.2)
Mild problem	186 (16.8)	102 (55.1)	191 (20.4)	107 (56.6)
Moderate problem	113 (10.2)	62 (55.9)	110 (11.7)	54 (49.5)
Major problem	81 (7.3)	30 (39.0)	52 (5.6)	22 (43.1)
Depression [41; 18]				
No	982 (84.9)	578 (59.3)	849 (83.5)	556 (66.0)
Yes	175 (15.1)	65 (38.0)	168 (16.5)	62 (37.8)
Policy-related characteristics				
Financial compensation (state/private insurance)				
General pension [0; 0]				
Occupational pension [yes]	180 (15.0)	69 (38.3)	148 (14.3)	83 (56.1)
Social benefits [yes]	95 (7.9)	22 (23.4)	88 (8.5)	23 (26.4)
Life insurance pension [yes]	78 (6.5)	43 (55.1)	54 (5.2)	35 (64.8)
Unemployment pension [yes]	14 (1.2)	3 (21.4)	10 (1.0)	4 (40.0)
Family allowance [yes]	119 (9.9)	81 (68.1)	107 (10.3)	68 (64.8)
Other benefits [yes]	99 (8.3)	33 (33.3)	27 (2.6)	14 (53.9)
Number of general pensions [1 or more]	497 (41.5)	211 (42.5)	375 (36.2)	197 (53.1)
General disability pension [0; 0]				
Helplessness allowance [yes]	647 (54.0)	336 (52.0)	486 (47.0)	275 (56.9)
Accident insurance pension [yes]	565 (47.2)	327 (58.3)	372 (35.9)	234 (63.2)
Care compensation [yes]	66 (5.5)	32 (48.5)	47 (4.5)	24 (51.1)
Number of disability pensions (except IV) [1 or more]	1005 (83.9)	531 (53.1)	749 (72.4)	425 (57.4)
IV pension level [12; 100]				
None	514 (43.3)	364 (70.8)	343 (36.7)	273 (80.3)
1/4	36 (3.0)	25 (69.4)	65 (7.0)	52 (81.3)
1/2	147 (12.4)	121 (82.3)	142 (15.2)	115 (81.6)
3/4	79 (6.7)	47 (59.5)	81 (8.7)	55 (68.8)
Full	410 (34.6)	107 (26.1)	304 (32.5)	91 (30.3)
Continuous variables [missing[a]]	*Median (IQR)*	*Median (IQR)*	*Median (IQR)*	*Median (IQR)*
Age (years) [0; 0]	48 (39–56)	46 (38–54)	51 (42–57)	49 (40–56)
Education (years) [21; 41]	13 (12–16)	14 (13–17)	14 (12–17)	15 (13–17)
Time since injury (years) [20; 76]	15 (7–25)	15 (7–25)	17 (8–27)	17 (9–27)
SCIM-SR total score (years) [34; 144]	74 (68–78)	75 (71–80)	74 (69–80)	76 (71–84)

Percentages are calculated excluding missing data. Percentages in the columns "Employed" reflect the proportion of individuals of a particular sub-group (e.g., females) who are involved in paid work in relation to the total number of individuals in this sub-group (visible in the columns "Total").

SCI spinal cord injury, *IV* Swiss Disability Insurance, *SCIM-SR* Spinal Cord Independence Measure-Self Report.

[a]Number of missing data for surveys 2012 and 2017.

Dynamic determinants

Education, pain, urinary tract infection, pressure ulcer, depression, and functional independence were strongly and consistently associated with between-person variation in LMP in the univariable analyses. *Functional independence*, with odds ratios between 1.08 and 1.12, as well as *education*, with an 80–90% decreased LMP likelihood for individuals with only a compulsory or a vocational education (compared to those with a university education), remained

Table 2 Static, temporal, dynamic, and policy-related determinants of between-person variation in labor market participation.

	Univariable analysis		Multivariable analysis (model 1) ($n = 2001$) ICC = 0.78 (95% CI 0.71–0.85)		Multivariable analysis (model 2) ($n = 1766$) ICC = 0.68 (95% CI 0.57–0.78)		Multivariable analysis (model 3) ($n = 1715$) ICC = 0.62 (95% CI 0.46–0.76)	
Parameter	Unadjusted odds ratio (95% CI)	*P* value[a]	Adjusted odds ratio (95% CI)	*P* value[a]	Adjusted odds ratio (95% CI)	*P* value[a]	Adjusted odds ratio (95% CI)	*P* value[a]
Static determinants								
Sex [*ref: Female*]		<0.0001		<0.0001		<0.001		<0.003
Male	3.85 (2.05–7.22)		4.20 (2.30–7.69)		2.32 (1.36–3.97)		2.17 (1.28–3.66)	
Nationality [*ref: Non*-Swiss]		<0.0001		<0.0001		<0.0001		<0.0001
Swiss	5.73 (2.84–11.53)		6.47 (3.25–12.87)		3.44 (1.80–6.56)		4.10 (2.09–8.02)	
SCI severity [*Paraplegia, incomplete*]		<0.0001		<0.0001		<0.0002		<0.058
Paraplegia, complete	0.95 (0.54–1.66)		0.61 (0.34–1.10)		1.18 (0.66–2.11)		0.86 (0.48–1.54)	
Tetraplegia, incomplete	0.24 (0.12–0.51)		0.20 (0.10–0.41)		0.30 (0.16–0.59)		0.49 (0.26–0.95)	
Tetraplegia, complete	0.21 (0.09–0.50)		0.12 (0.05–0.29)		1.05 (0.44–2.52)		1.37 (0.58–3.23)	
SCI etiology [*Non traumatic*]		<0.057		<0.093		<0.057		<0.160
Traumatic	2.07 (1.02–4.20)		1.92 (0.94–3.90)		1.94 (0.99–3.82)		1.64 (0.82–3.29)	
Temporal determinants								
Age [*ref: 16–24 years*]		<0.0001		<0.0001		<0.0001		<0.0001
25–39 years	26.61 (5.81–121.90)		22.20 (4.85–101.61)		15.26 (3.80–61.23)		19.27 (5.04–73.63)	
40–54 years	13.49 (3.12–58.35)		8.36 (1.93–36.16)		8.90 (2.32–34.16)		17.73 (4.72–66.59)	
55–63/64 years	3.31 (0.80–13.68)		1.55 (0.37–6.55)		2.61 (0.69–9.88)		8.07 (2.23–29.17)	
Time since injury [*ref: ≤5 years*]		<0.051		<0.073		<0.110		<0.234
6–15 years	1.60 (0.86–2.96)		1.17 (0.62–2.19)		1.07 (0.58–1.99)		1.52 (0.81–2.85)	
16–25 years	2.64 (1.29–5.42)		1.97 (0.94–4.11)		1.58 (0.78–3.18)		1.73 (0.85–3.51)	
≥26 years	2.04 (0.99–4.19)		2.34 (1.07–5.12)		2.13 (1.02–4.46)		2.13 (1.01–4.48)	
Survey year [*ref: 2012*]		<0.057		<0.008		<0.098		<0.052
2017	1.41 (1.01–1.99)		1.67 (1.16–2.41)		1.38 (0.94–2.02)		1.49 (0.99–2.23)	
Dynamic determinants								
Education level [*ref: University*]		<0.0001				<0.0001		<0.0001
Compulsory (≤9 years)	0.01 (0.00–0.06)				0.08 (0.03–0.24)		0.17 (0.06–0.50)	
Vocational (10–12 years)	0.05 (0.02–0.12)				0.12 (0.06–0.24)		0.20 (0.10–0.42)	
Secondary (13–16 years)	0.25 (0.14–0.47)				0.36 (0.21–0.65)		0.50 (0.28–0.88)	
Pain [*ref: No problem*]		<0.0001				<0.0001		<0.018
Mild problem	1.91 (1.00–3.65)				1.39 (0.72–2.67)		1.44 (0.75–2.75)	
Moderate problem	0.85 (0.46–1.56)				0.99 (0.54–1.82)		1.23 (0.67–2.27)	
Major problem	0.19 (0.10–0.37)				0.32 (0.17–0.59)		0.59 (0.33–1.07)	
Urinary tract infection [*ref: No problem*]		<0.0001				<0.501		<0.496
Mild problem	0.49 (0.27–0.88)				0.81 (0.46–1.41)		0.75 (0.42–1.33)	
Moderate problem	0.31 (0.17–0.57)				0.73 (0.41–1.30)		0.70 (0.39–1.25)	
Major problem	0.21 (0.10–0.42)				0.61 (0.32–1.17)		0.64 (0.34–1.21)	
Pressure ulcer [*ref: No problem*]		<0.0003				<0.565		<0.453
Mild problem	0.51 (0.28–0.92)				0.85 (0.49–1.50)		0.93 (0.53–1.63)	
Moderate problem	0.43 (0.21–0.91)				1.24 (0.62–2.46)		1.51 (0.75–3.04)	
Major problem	0.15 (0.05–0.41)				0.64 (0.27–1.52)		0.71 (0.31–1.63)	
Depression [*ref: No*]		<0.0001				<0.001		<0.031
Yes	0.17 (0.09–0.34)				0.36 (0.19–0.66)		0.51 (0.28–0.94)	
Functional independence (SCIM-SR total score)	1.16 (1.12–1.21)	<0.0001			1.12 (1.09–1.16)	<0.0001	1.08 (1.04–1.11)	<0.0001
Policy-related determinants								
General pension (*n*) [*ref: None*]		<0.0001						<0.0001
1 or more	0.13 (0.07–0.25)						0.27 (0.16–0.45)	
General disability pension (*n*) [*ref: None*]		<0.001						<0.562
1 or more	0.40 (0.23–0.69)						1.19 (0.66–2.13)	
IV pension level [*ref: None*]		<0.0001						<0.0001
1/4	1.22 (0.47–3.21)						0.69 (0.26–1.84)	
1/2	2.48 (1.23–5.00)						2.60 (1.24–5.45)	
3/4	0.43 (0.18–0.99)						0.67 (0.29–1.51)	
Full	0.12 (0.00–0.05)						0.05 (0.02–0.10)	

ICC for the null model (only including ID and no determinants) is 0.80 (95% CI 0.73–0.85). Odds ratios are derived from logistic regression analysis with labor market participation as dependent variable. Model 1: static and temporal determinants only. Model 2: static, temporal and dynamic determinants. Model 3: full model including static, temporal, dynamic and policy-related determinants.

SCI spinal cord injury, *IV* Swiss Disability Insurance, *ICC* intra-class correlation coefficient.

[a]From likelihood ratio testing (following weighted logistic regression analysis with robust standard errors).

Table 3 Counterfactual predictions of the employment rate for improvements in modifiable dynamic and policy-related determinants.

	Model 1: Without policy-related determinants ($n = 1766$)		Model 2: With policy-related determinants ($n = 1715$)	
Parameter [% of participants shifted to adjacent and advantageous level]	Employment rate (%)	Max Δ (%)	Employment rate (%)	Max Δ (%)
Education level *[Compulsory, Vocational, Secondary, University]*				
0	60%	0%	61%	0%
20	62%	2%	62%	1%
40	63%	3%	63%	2%
60	65%	5%	64%	3%
80	66%	6%	65%	4%
100	68%	8%	66%	5%
Pain *[Major, Moderate, Mild, None]*				
0	60%	0%	61%	0%
20	61%	1%	61%	0%
40	62%	2%	62%	1%
60	63%	3%	62%	1%
80	64%	4%	63%	2%
100	65%	5%	63%	2%
Depression *[Yes, No]*				
0	60%	0%	61%	0%
20	61%	1%	61%	0%
40	61%	1%	61%	0%
60	61%	1%	62%	1%
80	62%	2%	62%	1%
100	62%	2%	62%	1%
Functional independence *[10 points improvement on SCIM-SR total score]*				
0	60%	0%	61%	0%
20	62%	2%	62%	1%
40	65%	5%	64%	3%
60	67%	7%	65%	4%
80	69%	9%	66%	5%
100	71%	11%	67%	6%
IV pension level *[full → ¾, ¼, ¾, none → ½]*				
0			61%	0%
20			64%	3%
40			67%	6%
60			70%	9%
80			73%	12%
100			76%	15%

Differences in the starting value (baseline LMP rate) are due to differences in full case data sets of model 1 and 2.

SCIM-SR Spinal Cord Independence Measure-Self Report, *IV* Swiss Disability Insurance.

strong determinants in both multivariable models. Among the secondary conditions, only *pain* continued to be a strong determinant in the multivariable analyses, with individuals indicating major problems showing a 41 to 68% lower LMP probability than those reporting no pain issues. *Depression* remained important in the multivariable models as well,

with a 49 to 64% decreased LMP likelihood for participants with depression.

Policy-related determinants

Policy-related determinants were strongly associated with between-person variation in LMP across all univariable and multivariable analyses, with the exception of general disability pension in model 3. Individuals receiving at least one *general pension* were 73% less likely to have paid work than those with no general pension. Compared to participants with no IV pension, those with a full *IV pension* had a 0.95 times lower and those with a ½ IV pension a 2.6 times higher chance of LMP. Overall, the strong effect of policy-related determinants in model 3 went along with decreased values for the health-related determinants (compared to model 2), in particular for urinary tract infection and pressure ulcer and, to a lesser extent, for SCI severity and pain.

Counterfactual predictions of employment rate

Table 3 shows the counterfactual predictions of the employment rates for modifiable dynamic and policy-related determinants. In the analysis without policy-related determinants (model 1), the shift of 20 up to 100% of the participants to the adjacent, more advantageous level showed the highest improvement in employment rates for functional independence (up to an 11% increase for a 10-point rise in the SCIM-SR total score), followed by education (up to an 8% increase for a shift to the adjacent higher education level) and chronic pain (up to a 5% increase for a shift to the adjacent less severe pain level). In the analysis with policy-related determinants included (model 2), the scope of improvement was much narrower for pain (only a 2% increase), but still up to 6% for functional independence and 5% for education, respectively. A change in the IV pension level (i.e., shifting participants with no, ¼ or ¾ pension to a ½ IV pension and those with a full pension to a ¾ pension) increased the employment rate by up to 15%.

Discussion

Based on data for a large sample of individuals with SCI living in Switzerland, we observed considerable variation in LMP, which was strongly determined by static and temporal (sex, age, nationality, SCI severity), dynamic (education, functional independence, chronic pain, depression), and policy-related characteristics (general pensions, disability pension level). Counterfactual predictions of the employment rate in the study sample suggested a high scope of improvement for policies that foster functional independence and education, or that promote partial instead of full disability pension levels in the Swiss social security scheme.

Going beyond the existing scientific evidence, we showed that longitudinal variation in LMP of persons with SCI is more strongly attributable to differences between individuals than to latent factors that determine changes in the employment status of persons over time. Our multivariable models explained up to one fourth of between-person differences in LMP. The remaining variance might be explained by occupational factors (e.g., pre-injury job type), the receipt of vocational rehabilitation services or psychological personal factors (e.g., personal attitudes) that were not addressed in our study. There is, for instance, strong evidence that return-to-work opportunities are particularly reduced for individuals with a physically demanding pre-injury job [8]. The low likelihood of changes in participants' employment status during the 5-year time window of the SwiSCI surveys suggests a high chance for employed individuals to stay in the labor market and a high risk for non-working persons to stay unemployed. This finding emphasizes the importance of investing in return-to-work and job retention programs.

Our findings as to the determinants of between-person variation are in agreement with the mostly cross-sectional evidence on factors associated with paid work of persons with SCI in highly developed economies and welfare systems, both internationally [1, 2, 7, 13, 16] and in Switzerland [6, 10, 14]. In terms of *static and temporal* determinants, we showed being female, having a non-Swiss nationality and age over 54 to be *risk factors* for non-participation in the Swiss labor market. While older workers with SCI may be more likely to drop out of the labor market [27], females are more likely to not have paid work due to their higher engagement in childcare or housekeeping tasks. These differences are not SCI-specific but resemble differences in LMP in the general population, as discussed in existing research [6, 9]. Non-Swiss individuals are more often engaged in physically demanding jobs pre-injury and the transition to a white collar job type that matches one's physical capacities post-SCI may be hampered by insufficient educational and language skills [14]. Such vulnerable groups should receive particular attention in LMP research, but also in terms of more inclusive labor market policies. As to SCI severity, we showed persons with tetraplegia to be the most vulnerable group. However, the effect of SCI severity decreased when adding dynamic and policy-related determinants to the analysis, implying strong associations between SCI severity, secondary conditions, functional independence, and disability pension level that should be studied in future research.

At the level of *dynamic* determinants, education and functional independence turned out to be promising areas

for interventions to enhance the employment rate. As previously shown, a person's pre-injury as well as post-injury education are crucial factors for LMP [6, 7, 14]. Low functional independence was previously found to impede LMP beyond health-related factors and is linked to high extra time needs for managing daily life, a key barrier for LMP in persons with SCI [14, 28]. Functional independence training, and the provision of assistive devices and personal assistance, are thus promising strategies for enhancing individuals' LMP prospects. Finally, in line with previous evidence [29], our study revealed an impact of pain and depression on LMP. Though they showed a slightly reduced effect when adding policy-related determinants to the multivariable regression model and were not the most promising targets for enhancing employment rates, the complex interrelationship between pain and depression should be further studied to come up with customized vocational rehabilitation strategies for people with SCI.

With regard to *policy-related determinants*, the decreased tendency of LMP for individuals receiving a general pension (e.g., occupational pension, social or unemployment benefits) was not surprising. A more interesting finding was that individuals with a partial (½) IV pension showed a higher LMP probability than those with no IV pension. An explanation for this finding could be that a partial pension might improve the prospects of people with SCI for a fast return to work with reduced work hours at the pre-injury employer. Yet as previously shown, this does not necessarily results in a more sustained LMP [30]. A more likely explanation might be that receiving a partial IV pension increases the likelihood of working part-time, which is, in the long run, more suitable for most persons with SCI. Full-time work, especially if it requires an amount of effort that goes beyond the individuals' physical or mental capacities, is more likely to affect individual's health and can trigger premature labor market drop out. This explanation is supported by a recently conducted qualitative study in Switzerland [15]. Promotion of partial instead of full disability pension levels while ensuring sufficient part-time work opportunities for individuals with SCI could thus be a promising strategy for ensuring sustainable employment in the Swiss SCI population.

Strengths and limitations

The strength of our study is the comprehensive longitudinal data set allowing us to distinguish between-person and within-person variation for deriving counterfactual predictions on a population level. By indicating the scope of improvement resulting from interventions targeting modifiable determinants of LMP, we provide a policy-driven view beyond the mere discussion of relationships in regression modeling as done in most previous studies.

Yet our study also has several limitations. First, our analysis is based on self-report data and the reliability and validity of some responses might be influenced by latent personal characteristics (e.g., personality, attitudes) as well as by recall and social desirability biases. For instance, LMP responses might be biased by social desirability. Moreover, a previous comparison with the medical records (for those participants available) indicates that SCI severity may be non-differentially misclassified in about 15% of the self-report responses [18]. Second, our study missed important information on participants' previous jobs (whether pre- or post-injury), on whether currently unemployed participants did ever return to work and then dropped out from employment post-SCI, and on psychological personal factors as key determinants of LMP. Future research should thus complement our study by considering career trajectories and personal factors that may contribute to the explanation of between-person variation in LMP. Finally, in our counterfactual evaluation we assumed causality between the determinants and LMP and implied that the policy-related characteristics do not influence the dynamic determinants. A causal mediation analysis should thus test whether the counterfactual predictions are justified.

Practical, policy, and research implications

In conducting a longitudinal study on the determinants of between-person variation in LMP and their instrumental value for policy interventions in the context of the Swiss labor market and social security scheme, our analysis does not only reveal groups at risk of non-participation in the labor market but also provides input on how to potentially enhance LMP in the Swiss SCI population. Our findings suggest that investments in programs enhancing education and functional independence and promoting partial disability pensions are promising strategies to improve the employment rate. While such information is crucial from a policy perspective, it needs to be complemented by evidence on the determinants of within-person variation at an individual level to properly inform vocational rehabilitation practice. Although our findings are primarily applicable to Switzerland, the underlying determinants and pathways indicated in Fig. 1 are likely to be universal and thus also applicable to other settings, although policy implementation requires setting-specific adaptation. For instance, our counterfactual predictions regarding disability pension levels may apply to other settings with a graded pension plan, irrespective of differences in the detail of the pension scheme as compared to the Swiss system.

Future research should test the causality of the assumed relationships between dynamic and policy-related determinants and between-person variation in LMP with a focus on vulnerable groups (older individuals, non-Swiss, females,

individuals with tetraplegia) to derive prognostic models for specific SCI populations. Such population-based evidence should take into account the structures and dynamics of national labor market and social security systems and policies and should be complemented by research on within-person variation in LMP as well as by hypothesis-driven studies on the interrelationship between different determinants of LMP. In addition, more in-depth qualitative and quantitative research is needed to better understand the underlying dynamics of the determining effect of factors such as gender, nationality and disability pension levels on LMP of persons with SCI living in Switzerland.

Conclusion

Based on an analysis of a large sample of community-dwelling individuals with SCI living in Switzerland, we showed that LMP varies considerably between persons. This between-person variation is strongly determined by static and temporal (sex, age, nationality, SCI severity), dynamic (education, functional independence, chronic pain, depression), and policy-related characteristics (general pensions, disability pension level). Our study not only revealed females, older individuals, the non-Swiss, and persons with tetraplegia as vulnerable groups in terms of non-participation in the labor market, but also suggests that policy should particularly invest in programs promoting functional independence, education, and partial pensions to enhance LMP and ensure sustainable employment in the SCI population.

Data availability

Owing to our commitment to SwiSCI study participants and their privacy, data sets generated during the current study are not made publicly available but can be provided by the SwiSCI Study Center based on reasonable request (contact@swisci.ch).

Acknowledgements We thank the SwiSCI Steering Committee with its members Xavier Jordan, Fabienne Reynard (Clinique Romande de Réadaptation, Sion); Michael Baumberger, Hans Peter Gmünder (Swiss Paraplegic Center, Nottwil); Armin Curt, Martin Schubert (University Clinic Balgrist, Zürich); Margret Hund-Georgiadis, Kerstin Hug (REHAB Basel, Basel); Laurent Prince (Swiss Paraplegic Association, Nottwil); Heidi Hanselmann (Swiss Paraplegic Foundation, Nottwil); Daniel Joggi (Representative of persons with SCI); Nadja Münzel (Parahelp, Nottwil); Mirjam Brach, Gerold Stucki (Swiss Paraplegic Research, Nottwil); Armin Gemperli (SwiSCI Coordination Group at Swiss Paraplegic Research, Nottwil).

Funding SwiSCI is hosted and funded by Swiss Paraplegic Research.

Author contributions US, MWGB, and CF were responsible for designing the conceptual framework of the study. MWGB conducted the statistical analysis. US and MWGB prepared the paper. CF, MF, KK, and SS substantially contributed to the data interpretation or the article preparation. SS provided valuable input from vocational rehabilitation practice.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Ethical approval for the SwiSCI Survey 2012 was granted by the principal ethics committee on research involving humans of the Canton of Lucerne (KEK Luzern, internal application 11042, approved 28.06.2011) and subsequently endorsed by the additional involved cantonal ethics committees of the Cantons Basel-Stadt (EK Basel, internal application 306/11, approved 06.09.2011) and Valais (CCVEM Sion, internal application CCVEM042/11, approved 06.12.2011). Ethical approval for the SwiSCI Survey 2017 was granted by the leading ethical institution Ethikkommision Nordwest-und Zentralschweiz (EKNZ, Project-ID: 11042 PB_2016-02608, approved Dec 2016). We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were followed during the course of this research.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

1. Ottomanelli L, Lind L. Review of critical factors related to employment after spinal cord injury: implications for research and vocational services. J Spinal Cord Med. 2009;32:503–31.
2. Lidal IB, Huynh TK, Biering-Sörensen F. Return to work following spinal cord injury: a review. Disabil Rehabil. 2007;29:1341–75.
3. Cao Y, Krause JS. Estimation of indirect costs based on employment and earnings changes after spinal cord injury: an observational study. Spinal Cord. 2020;98:909–13.
4. Leiulfsrud AS, Ruoranen K, Ostermann A, Reinhard JD. The meaning of employment from the perspective of persons with spinal cord injuries in six European countries. Work. 2016;55:133–44.
5. Frieden L, Winnegar AJ. Opportunities for research to improve employment for people with spinal cord injuries. Spinal Cord. 2012;50:379–81.
6. Reinhardt JD, Post MW, Fekete C, Trezzini B, Brinkhof MW. Labor market integration of people with disabilities: results from the swiss spinal cord injury cohort study. PloS ONE. 2016;11:e0166955.
7. Trenaman L, Miller WC, Queree M, Escorpizo R. SCIRE research team. modifiable and non-modifiable factors associated with employment outcomes following spinal cord injury: a systematic review. J Spinal Cord Med. 2015;38:422–31.
8. Escorpizo R, Miller WC, Trenaman LM. Work and employment. In: Eng JJ, Teasell RW, Miller WC, Wolfe DL, Townson AF, Hsieh JTC, et al. editors. Spinal cord injury rehabilitation evidence. Vancouver; 2012;4:1–22.
9. Leiulfsrud AS, Solheim EF, Reinhardt JD, Post MWM, Horsewell J, Biering-Sörensen F, et al. Gender, class, employment status and social mobility following spinal cord injury in Denmark, the Netherland, Norway and Switzerland. Spinal Cord. 2020;58:224–31.
10. Marti A, Boes S, Lay V, Escorpizo R, Trezzini B. The association between chronological age, age at injury and employment: Is there a mediating effect of secondary health conditions? Spinal Cord. 2016;54:239–44.

11. Burns SM, Boyd BL, Hill J, Hough S. Psychosocial predictors of employment status among men living with spinal cord injury. Rehabil Psychol. 2010;55:81–90.
12. Murphy G, Middleton J, Quirk R, De Wolf A, Cameron ID. Prediction of employment status one year post-discharge from rehabilitation following traumatic spinal cord injury: an exploratory analysis of participation and environmental variables. J Rehabil Med. 2009;41:1074–9.
13. Krause JS, Reed KS. Barriers and facilitators to employment after spinal cord injury: underlying dimensions and their relationship to labor force participation. Spinal Cord. 2011;49:285–91.
14. Schwegler U, Fellinghauer CS, Trezzini B, Siegrist J. For the SwiSCI Study Group. Factors associated with labor market participation of persons with traumatic SCI in Switzerland: analyzing the predictive power of social background, health, functional independence, and the environment. Spinal Cord. 2019;58:411–22.
15. Marti A, Escorpizo R, Schwegler U, Staubli S, Trezzini B. Employment pathways of individuals with spinal cord injury living in Switzerland: a qualitative study. Work. 2017;58:99–110.
16. Krause JS, Terza JV. Injury and demographic factors predictive of disparities in earnings after spinal cord injury. Arch Phys Med Rehabil. 2006;87:1318–26.
17. Post MW, Brinkhof MW, von Elm E, Boldt C, Brach M, Fekete C, et al. Design of the Swiss Spinal Cord Injury Cohort Study. Am J Phys Med Rehabil. 2011;90:S5–16.
18. Brinkhof MW, Fekete C, Chamberlain JD, Post MW, Gemperli A. Swiss national community survey on functioning after spinal cord injury: Protocol, characteristics of participants and determinants of non-response. J Rehabil Med. 2016;48:120–30.
19. Gross-Hemmi MH, Gemperli A, Fekete C, Brach M, Schwegler U, Stucki G. Methodology and study population of the second Swiss national community survey of functioning after spinal cord injury. Submitted to Spinal Cord. 2020. https://doi.org/10.1038/s41393-020-00584-3. Epub ahead of print.
20. Swiss Spinal Cord Injury Cohort Study (SwiSCI). Community survey. Nottwil: Schweizer Paraplegiker-Forschung; 2018. https://www.swisci.ch/en/research-projects-home/study-design/community-survey/survey-2017. Accessed 15 Nov 2020.
21. UNESCO. International Standard Classification of Education (SCED). Paris: UNESCO; 1997.
22. Fekete C, Eriks-Hoogland I, Baumberger M, Catz A, Itzkovich M, Luthi H, et al. Development and validation of a self-report version of the Spinal Cord Independence Measure (SCIM III). Spinal Cord. 2013;51:40–7.
23. Prodinger B, Ballert CS, Brinkhof MW, Tennant A, Post MW. Metric properties of the spinal cord independence measure—self report in a community survey. J Rehabil Med. 2016;48:149–64.
24. Kalpakjian CZ, Scelza WM, Forchheimer MB, Toussaint LL. Preliminary reliability and validity of a Spinal Cord Injury Secondary Conditions Scale. J Spinal Cord Med. 2007;30:131–9.
25. Sangha O, Stucki G, Liang MH, Fossel AH, Katz JN. The self-administered comorbidity questionnaire: a new method to assess comorbidity for clinical and health services research. Arthritis Rheum. 2003;49:156–63.
26. Twisk J. Missing data in longitudinal studies. In: Applied longitudinal data analysis for epidemiology: a practical guide. Cambridge: Cambridge University Press; 2013. p. 212–36.
27. Murphy GC, Jackson MS. Barriers to sustained return-to-work reported by those returning to work post traumatic spinal cord injury rehabilitation. Open Rehabil J. 2013;6:21–5.
28. Weissberg M. Berentung von jungen Querschnittgelähmten. Paracontact. 2008;1:15.
29. Müller R, Landmann G, Béchir M, Hinrichs T, Arnet U, Jordan X, et al. Chronic pain, depression and quality of life in individuals with spinal cord injury: Mediating role of participation. J Rehabil Med. 2017;49:489–96.
30. Trezzini B, Schwegler U, Reinhardt JD. Work and wellbeing-related consequences of different return-to-work pathways of persons with spinal cord injury living in Switzerland. Spinal Cord. 2018;56:1166–75.